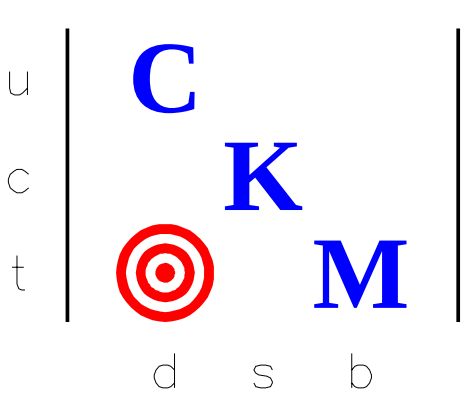
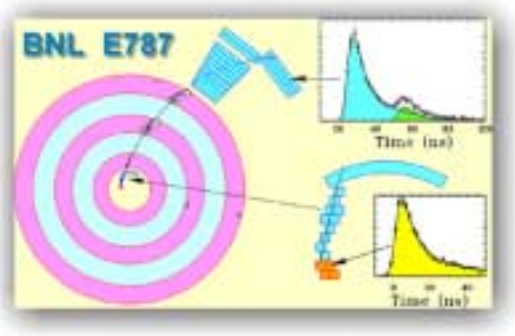


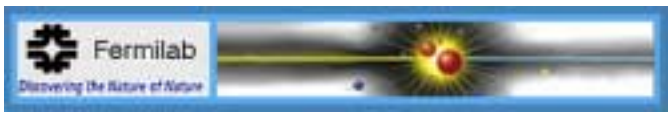


$K^+ \to \pi^+ \nu\overline{\nu}$

- Understanding of the nature of CP violation is a primary objective of the Office of Science (SC1)
- US has undisputed world leadership in the study of $K \to \pi\nu\overline{\nu}$ (currently)
  - Two $K^+ \to \pi^+ \nu\overline{\nu}$ events observed by E787 at BNL
  - E949 approved by DHEP, with 'high priority' after evaluation within the national HEP program, to build on hard won experience from (and investment in) E787 $\Rightarrow$ to observe $\sim$10 SM events.
  - Experience of E949 to be exploited in CKM, to reach the maximum possible sensitivity to $|V_{td}|$.
- *"...will provide critical input determining the unitarity triangle and testing the Standard Model hypothesis of CP violation. Comparisons .... [with] the B system will provide the best overall test of the SM picture and have the potential to reveal new physics."* BNL HENP PAC 10/12/98

Steve Kettell
BNL

DOE 10/18/02



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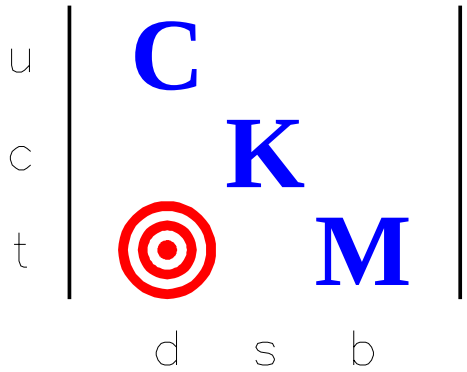

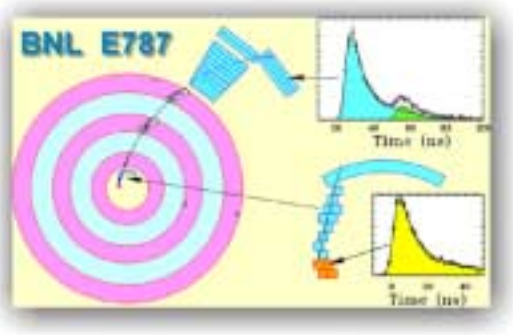

BNL in CKM

- BNL, FNAL management committment to $K^+ \to \pi^+ \nu\overline{\nu}$ through E949 and CKM (T. Kirk letter of 6/14/99)
- Jim Frank, Steve Kettell; tech./eng. support
  - contribution to VVS prototype: design, fiber layout, PMT testing
- Experience with $K^+ \to \pi^+ \nu\overline{\nu}$
  - analysis strategies, techniques
  - detector construction, especially PV

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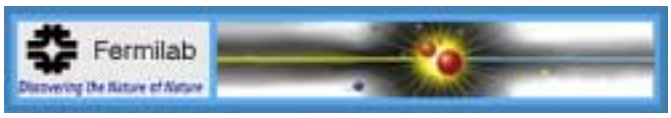

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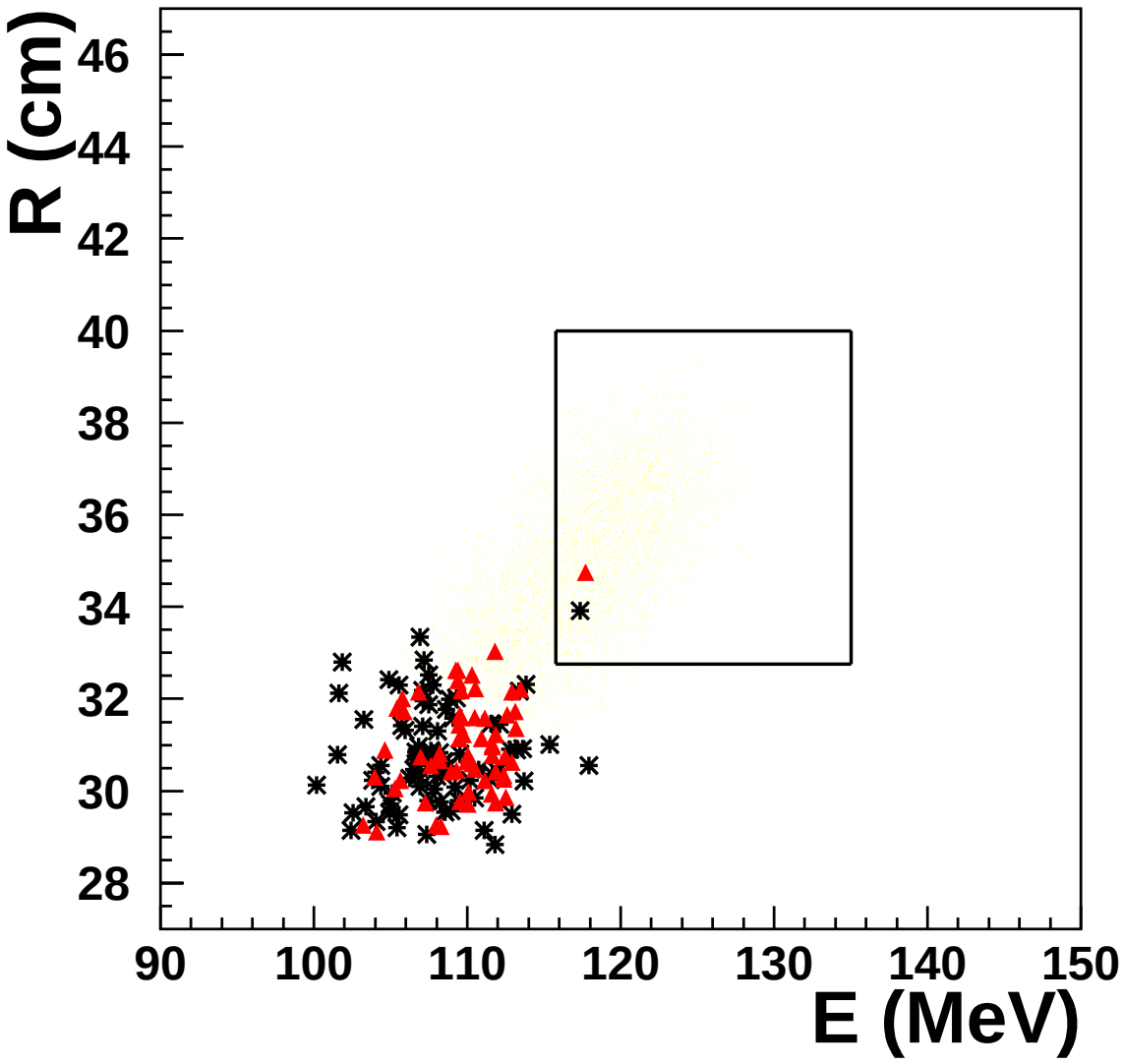
E787 $K^+ \to \pi^+ \nu\bar{\nu}$ Events

1995–98 Data



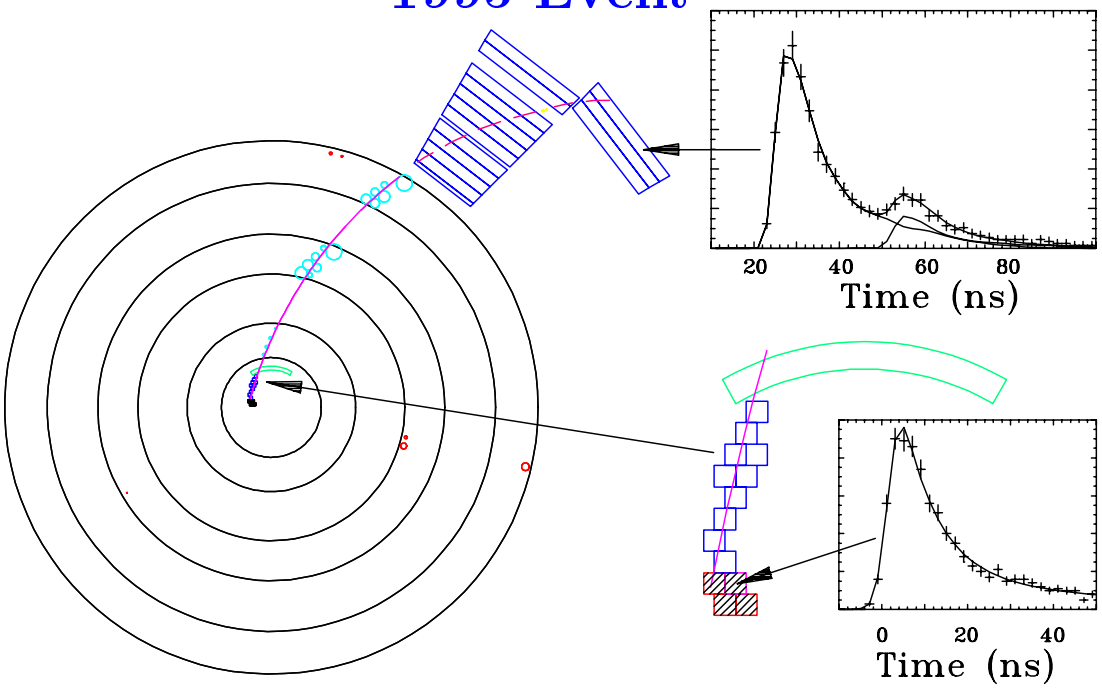
$$\mathbf{BR}(K^+ \to \pi^+ \nu\bar{\nu}) = 1.57^{+1.75}_{-0.82} \times 10^{-10}$$

[PRL cover: http://ojps.aip.org/prl/covers/88_4.jsp]

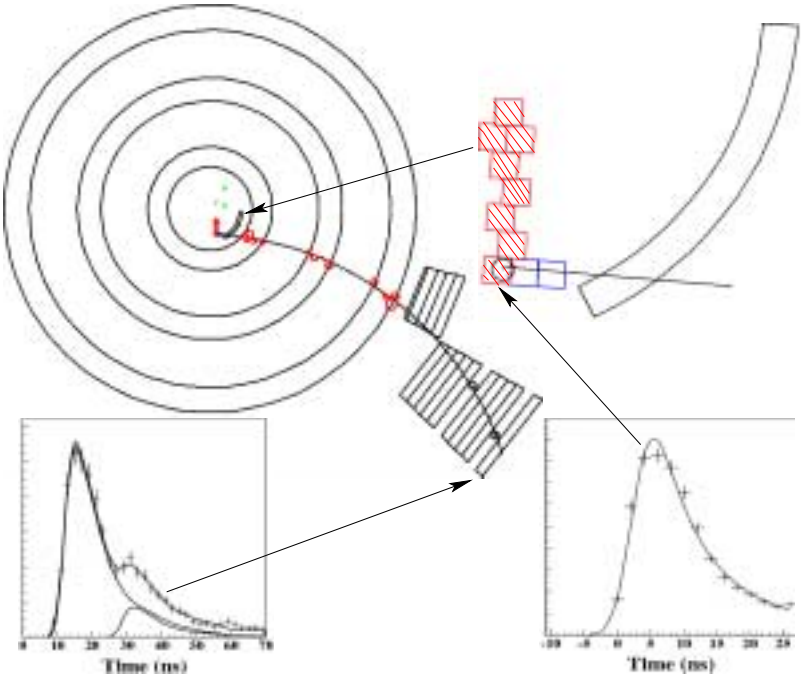
Looking forward to more statistics from E949 and then CKM; and to observation of B_s mixing (likely at the Tevatron).

The Two E787 $K^+ \to \pi^+ \nu\bar{\nu}$ Events

1995 Event



1998 Event

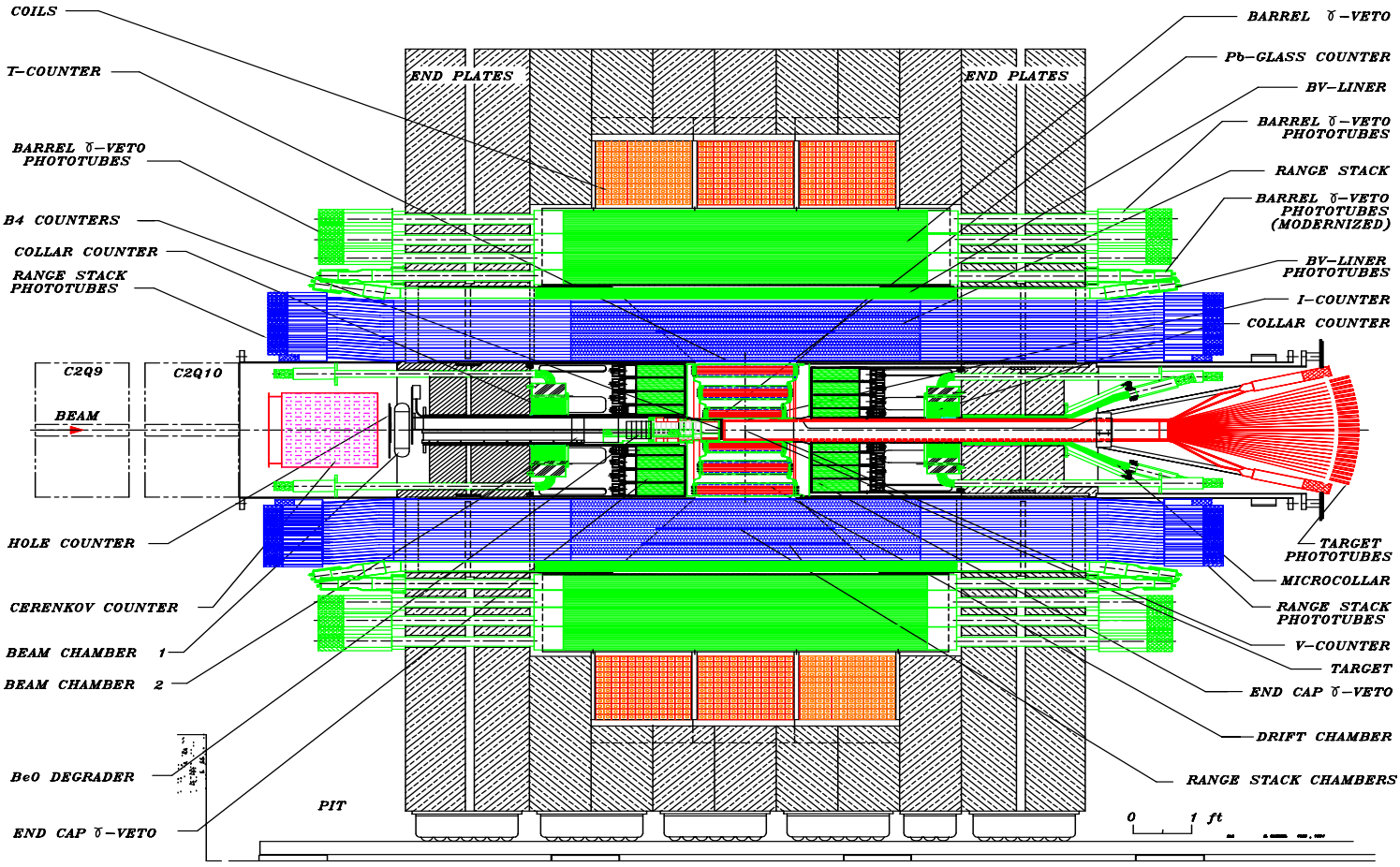


$$\mathbf{BR}(K^+ \to \pi^+ \nu\bar{\nu}\ ) = 1.57^{+1.75}_{-0.82} \times 10^{-10}$$

[1995–8: PRL **88**, 041803 (2002),
1995–7: PRL **84**, 3768 (2000),
1995: PRL **79**, 2204 (1997)]

E949: Measurement of B($K^+ \to \pi^+ \nu\overline{\nu}$)

Alberta/BNL/FNAL/Fukui/IHEP/INR/KEK/Kyoto/UNM/Osaka/TRIUMF

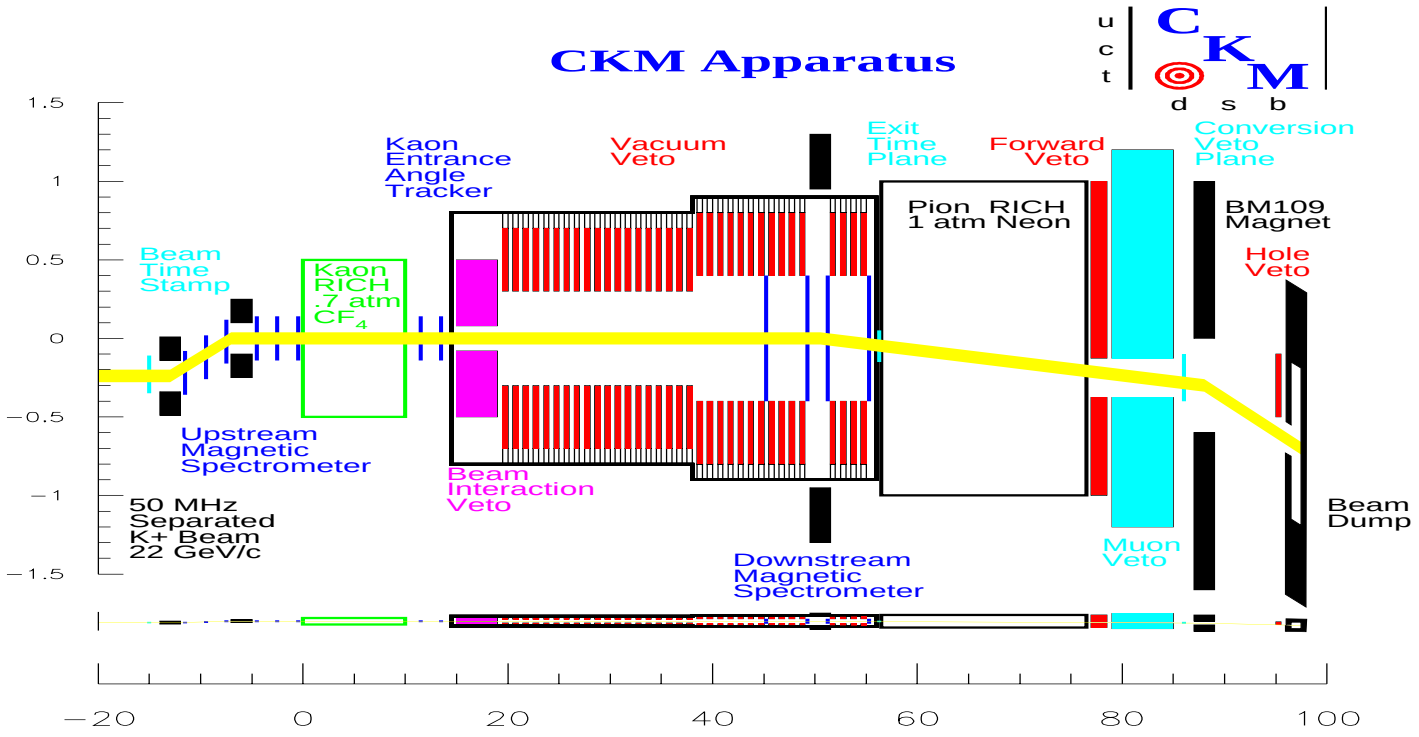


Sensitivity improvement with respect to E787 (1995):

- Increased spill length ($\times 1.56$)
- Lower Momentum ($\times 1.38$)
- Increased efficiency (trigger,DAQ,analysis) ($\times 3.2$)
- Acceptance below $K_{\pi 2}$ peak [$\times 2$]
- Total gain of $\times 7 - [14]$ (per hour of running)

$\Longrightarrow$ **Will observe 5–10 SM events in 2 years.**

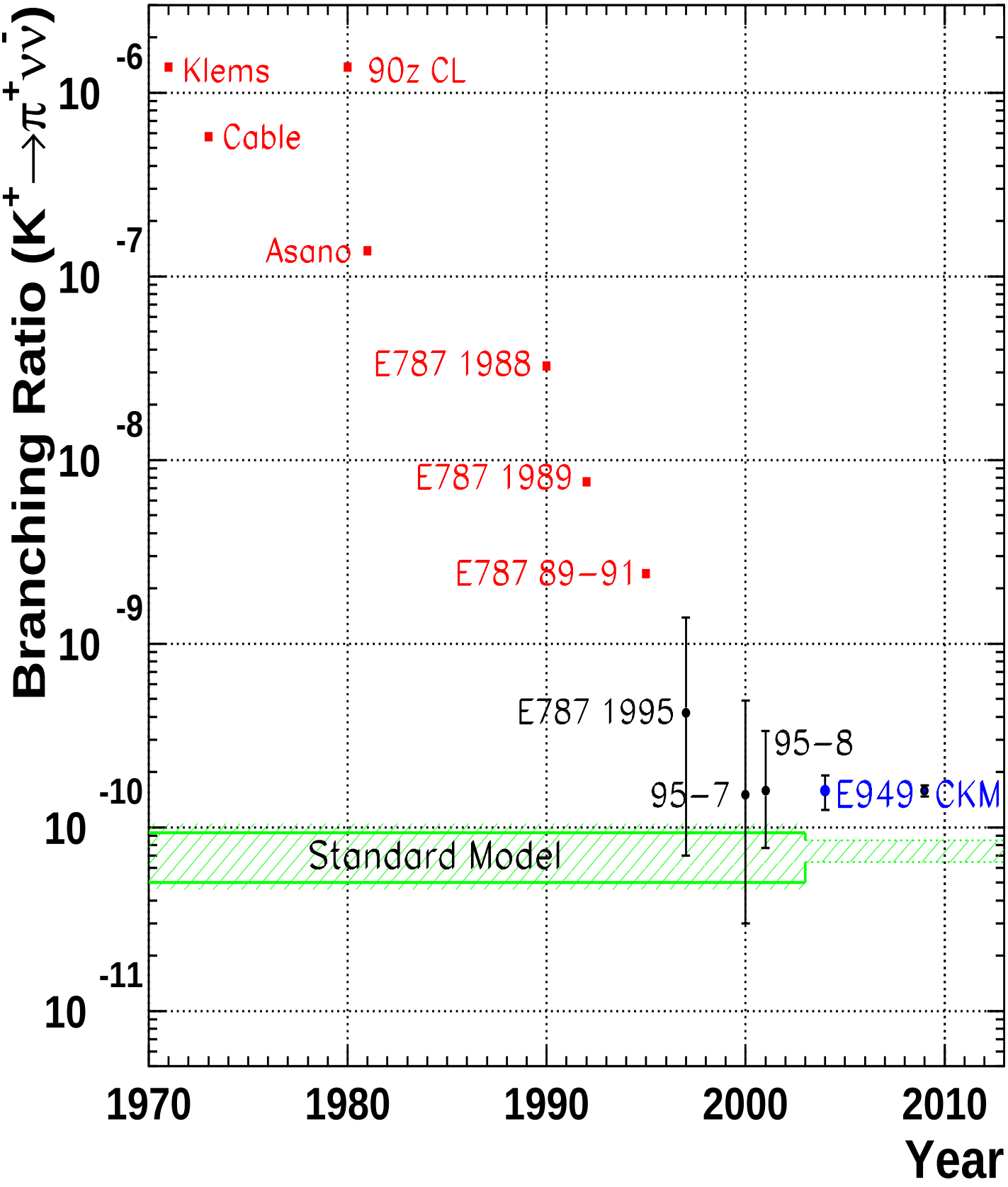
CKM: $K^+ \to \pi^+ \nu\overline{\nu}$



BNL/Colorado/FNAL/IHEP/INR/Michigan/ South Alabama/Texas/UASLP/Virginia

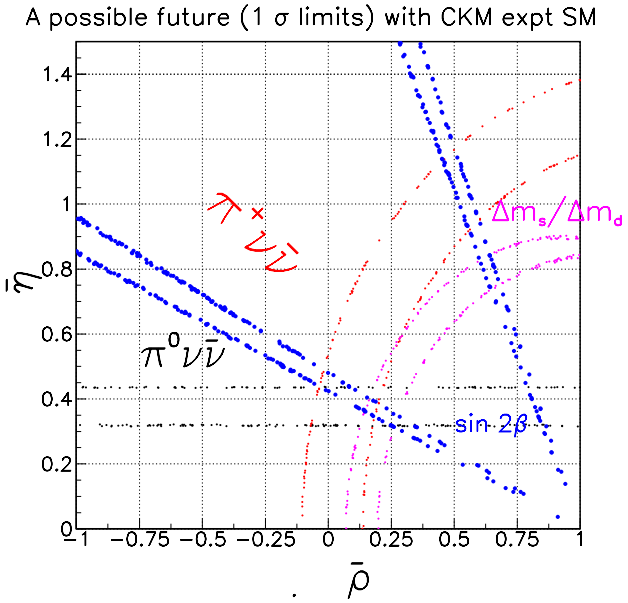
- Goal:
  - Measure B($K^+ \to \pi^+ \nu\overline{\nu}$) to 10% and determine $|V_{td}|$ to $\sim$ 7%.
- Sensitivity and background:
  - Observe $\sim$100 $K^+ \to \pi^+ \nu\overline{\nu}$ events in 2 years of Main Injector running
  - Background $\sim$10% (mostly $K_{\pi 2}$)
- Technique:
  - Slow extracted spill from MI 1s/3s, when not filling Tevatron
  - Decay in flight with a separated 22 Gev/c K^+ beam (K/π= 2:1).
  - Redundant kinematics: velocity (RHIC's) and momentum (straws in vacuum) spectrometers.
  - Hermetic photon veto, good μ-rejection.

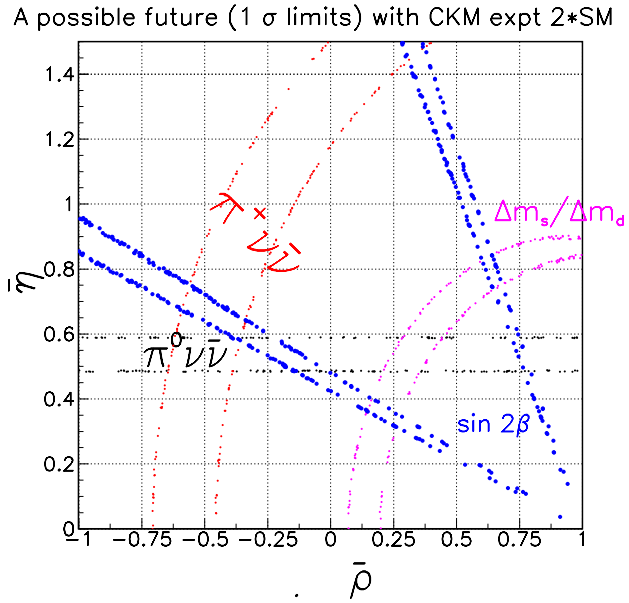
History of the Search for $K^+ \to \pi^+ \nu\bar{\nu}$

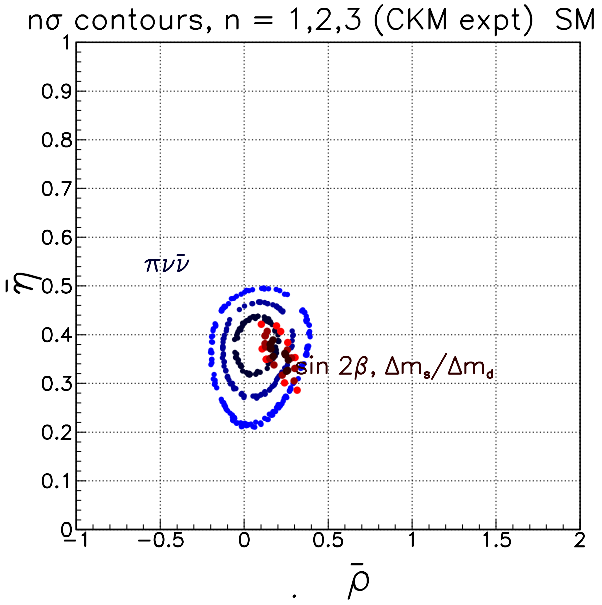


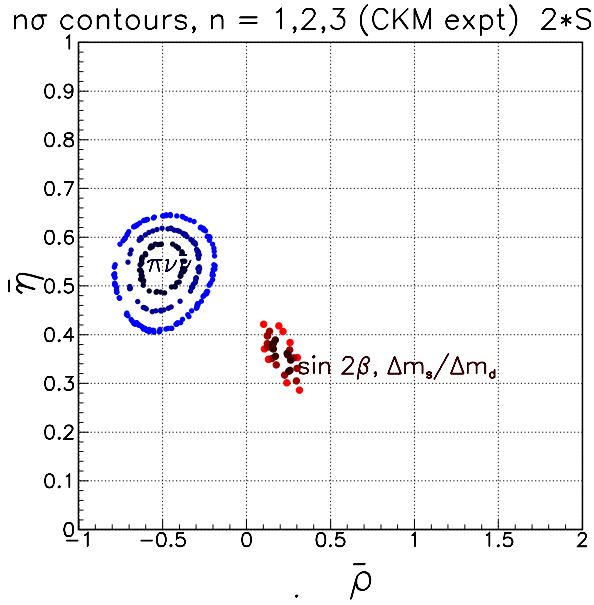
Conclusions

- After E949 reaches a sensitivity of ∼10 SM events (hopefully)
- Expect to see ∼100 SM events by the end of the decade from CKM









- ...and after comparison with the B-system may discover something new about CP violation... or provide a definitive validation of the SM picture of CP violation.